

High-Temperature Electrolysis

Unlocking Hydrogen's Potential with Nuclear Energy

Efficient production of hydrogen without increased greenhouse gas emissions is the key to achieving the “hydrogen economy” envisioned by the National Hydrogen Initiative. As the lead laboratory for the Department of Energy’s Office of Nuclear Energy, Science and Technology, the Idaho National Engineering and Environmental Laboratory is assuming a major role in developing technologies to produce hydrogen using nuclear energy. One of the most promising of these technologies is called high-temperature electrolysis.

What Is High-Temperature Electrolysis?

One way to produce hydrogen is electrolysis – using electricity to separate hydrogen from water. By performing electrolysis at high temperatures, its overall efficiency increases considerably. In a high-temperature electrolysis system using nuclear energy, a nuclear reactor supplies thermal energy that both generates the electricity and heats the steam needed for the electrolysis process. A high-temperature heat exchanger supplies high-pressure steam superheated to about 850 degrees Celsius. Heat

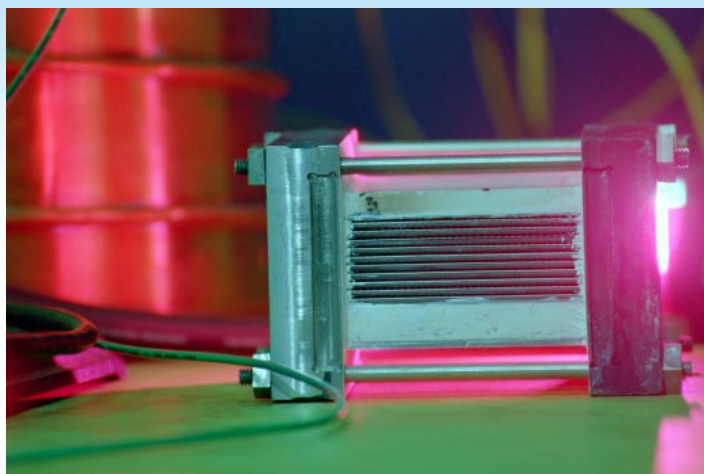
from the reactor is also used to generate electricity. The combination of electric power and superheated steam splits the hydrogen molecules out of water in a special separator.

The Advantages of Nuclear-Powered High-Temperature Electrolysis

Nuclear-powered high-temperature electrolysis is the key to efficient, clean production of hydrogen.

- High-temperature systems reduce the amount of electricity needed

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In fuel cells, hydrogen and oxygen are combined electro-chemically to produce water, and, in the process, heat and electricity. INEEL is experimenting with reversing the process – using solid-oxide cells to split water into hydrogen and oxygen while consuming electricity and heat.



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for hydrogen production, and make generating the electricity that is needed more efficient.

- A high-temperature advanced nuclear reactor coupled with a high-efficiency high-temperature electrolyzer would be extremely efficient, with a thermal-to-hydrogen conversion efficiency of 45 to 55 percent.
- Using nuclear energy rather than fossil fuels for electrolysis would allow hydrogen production with no associated greenhouse gas emissions.
- High-temperature electrolysis plants could serve an important balancing function, supplying ex-

cess electricity to the power grid when electricity demand is high or pulling electricity from the grid when demand is low to produce extra hydrogen.

It's Happening at INEEL

INEEL is leading research on using nuclear energy for high-temperature electrolysis. INEEL is already testing the use of solid-oxide cells – used mainly for power production in fuel cells – for electrolysis. In fuel cells, hydrogen and oxygen are combined electro-chemically to produce water, and, in the process, heat and electricity. INEEL is experimenting with reversing the process – using solid-oxide cells to split water into hydrogen and oxygen while consuming electricity and heat. A new genera-

tion of nuclear reactor under development at INEEL, the Very High Temperature Reactor, will eventually supply both electricity and high-temperature heat to the electrolyzer.

Conceptual design and analysis for hydrogen production facilities is underway at INEEL.

- A pre-conceptual design for a pilot-scale (500 kilowatts) high-temperature electrolysis facility is complete. The National Hydrogen Initiative's Research and Development Plan calls for the facility to be deployed around 2008.
- The plan calls for a larger 5 megawatt engineering demonstration facility to be developed at INEEL around 2011.

For More Information

Technical Contact:

Steve Herring
208-526-9497
sth@inel.gov

Management Contact:

Kathy McCarthy
208-526-9392
km3@inel.gov



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